Publication 870

November 1956
Revision

FERTILIZERS FOR VARIOUS CROPS

Agriculture Canada
Canadian Agriculture Library
Bibliothèque canadienne de l'agriculture
Ottawa K1A 0C5

CANADA DEPARTMENT OF AGRICULTURE
OTTAWA, ONTARIO

5M—22078—11:56

630.4
C212
P. 870
nov 1956
c.3

CONTENTS

Page

Introduction 3

The Soil 3

Previous Treatment of the Soil 4

Climatic Conditions 5

Fertilizer Requirements for Various Field Crops 5

Fertilizers for Market Garden Crops 7

Mineral Soils 7

Organic Soils 10

Fertilizers for Small Fruits 12

Strawberries 13

Bush and Cane Fruits 13

Fertilizers for Tree Fruits 13

Control Measures for Orchard Trace Element Deficiencies 15

Fertilizers for Tobacco 16

Sources of Commercial Tobacco Fertilizer Materials 17

Fertilizers for Tobacco Seedbeds 18

Fertilizers for Tobacco Crops in Ontario 18

Fertilizers for Tobacco Crops in Quebec 20

FERTILIZERS FOR VARIOUS CROPS

INTRODUCTION

While the use of animal manures for fertilizing soils has been common for hundreds of years, commercial fertilizers have more recently come to be considered an economic necessity on most soils. These commercial fertilizers are used in conjunction with green and barnyard manures, or alone.

Green plants synthesize their food from simple substances like carbon dioxide, water, nitrogen, phosphorus, and potassium which are absorbed from the soil and the air. It is common to speak of these substances as plant foods. In reality they are not foods but the raw materials from which the foods are made.

If the plant and soil needs could be determined simply, plant nutrients could be applied in sufficient quantities to supplement the nutrients already in the soil, so as to provide the correct proportion and amount of all the nutrients needed for the best possible growth of plants. In practice, however, such an ideal is difficult to attain. The soil is more or less an unknown quantity when one considers its potential to produce crops. It varies according to its nature and to the treatment it has received in cropping and management practices. Climatic conditions, particularly temperature and precipitation, are also unpredictable and greatly influence plant growth in soils, even when the nutrient conditions are favorable.

These three factors, nature of the soil, its past treatment, and climatic conditions, are probably the most important factors to consider, along with specific requirements of the crops concerned, when making fertilizer recommendations.

In a country as large as Canada with its many different kinds of soils and varying climatic conditions, it is obviously impossible to make fertilizer recommendations for a specific crop that will be applicable everywhere. In the following, some general suggestions for certain areas have been given. An attempt has been made to approximate normal requirements of the crops cited when grown on soils of medium fertility under good farming practices. These suggestions are based largely on results of experimental work conducted on Dominion Experimental Farms and Illustration Stations.

More specific recommendations can be obtained from local Experimental Farms and provincial fertilizer boards and extension workers.

The Soil

The soil is a living, changing system. Though its change is slow and often not noticeable, it is constant. For agricultural purposes the soil is a relatively thin layer several feet deep. It is made up of three main layers, topsoil, subsoil, and parent material.

The topsoil usually coincides closely with the plow furrow depth. It contains most of the nutrients available to plants and a large share of the water. The topsoil can be changed much more easily than the subsoil or parent material because it can be fertilized, limed, irrigated, drained, and tilled. Its fertility, and to a lesser extent its productivity, can be raised or lowered, or satisfactorily stabilized at levels consistent with economic crop production.

The subsoil is also important in the overall productivity of a soil. It contributes some nutrients. It usually contains little organic matter. It is subject to very little field alteration except drainage. When the subsoil is comprised of fine textured clay or silty materials it holds moisture and acts in some respects as a water storage reservoir. Water is inclined to seep through the coarser textured, sandy and gravelly subsoils, carrying plant nutrients with it and such soils are often droughty and low in fertility.

The parent material is deep in the soil and has little direct effect on soil productivity. It is the material from which the subsoil and mineral part of the surface soil is formed and, therefore, does contribute indirectly to the ultimate characteristics of these upper layers, and must be considered in the classification, use, and management of various soil types.

Components

There are four major components of soils: (*a*) mineral materials; (*b*) organic matter, (*c*) water and (*d*) air.

(*a*) Mineral materials. These comprise the bulk of soil solids. Various size or texture ranges occur naturally, from the relatively coarse gravels and sands to the finer silts and clays.

(*b*) Organic matter. This component is formed from accumulated plant and animal residues and is usually in an active state of decay. A sample of dry topsoil usually contains 2 to 6 per cent of organic matter, the remainder being mineral material. Peat and muck soils contain 50 per cent or more of organic matter on a dry basis, with the remainder comprised of mineral material. The management of these soils is quite different from that of the mineral soils.

(*c*) Water. This component is held in the pore spaces of the soil. In the field, the moisture content will vary widely but should be about 15 to 30 per cent for best plant growth. In the soil water are dissolved many nutrients which the plants can use.

(*d*) Air. The pore spaces in the soil not occupied by water are filled with air.

Classification

Soils are classified into groups according to texture, tilth, drainage, reaction, organic matter content, "available" plant nutrients and other factors. This classification takes into consideration all layers of the profile and is indispensable for making good fertilizer recommendations. Many of the soil types are similar so recommendations may be nearly the same for different areas. A knowledge of the soil types aids greatly in determining the best fertilizer to apply.

Previous Treatment of the Soil

Previous soil management and cropping practices exert considerable influence on the kind and amount of fertilizer to apply for maximum production of any crop to be grown subsequently. The previous use of manures and commercial fertilizers must be known. If mixed farming is followed, barnyard manure will no doubt be available in greater or lesser amounts. If fairly large amounts are available, it may only be necessary to supplement the manure with superphosphate, to provide a better balance of plant food nutrients. If there is not sufficient manure available for maximum production, supplementing it with a complete fertilizer relatively high in phosphorus is recommended.

In cash-crop areas where no livestock is kept, it is usually impossible to obtain barnyard manure. Soil productivity can be maintained under these circumstances by the use of commercial fertilizers only. Care must be taken, however, to add organic matter in some form, or the physical conditions of the soil may suffer and become a factor which may limit production. Crop residues, green manure crops, sod crops or other organic materials may be used to supplement the commercial fertilizer.

Legume crops such as alfalfa, red clover, alsike clover, ladino, peas, beans or soybeans are able to obtain nitrogen and store it in their roots for subsequent use by following crops. It is not necessary, therefore, to add much nitrogen for these crops during their growing period, nor for non-legume crops grown the year after the legume. These crops, however, are heavy feeders on minerals, and phosphorus and potassium must be applied in fairly large quantities.

Some crops are able to utilize nutrients from the soil better than others and thus it is desirable to have a rotation of crops. For instance, a grain crop may thrive by feeding on the residual or unused fertilizer applied to potatoes the year before. Similiarly, hay crops are often benefited by fertilizer applied to the grain crop, with which they have been seeded the year previous. It is advisable to think in terms of the fertilizer treatment affecting the whole rotation. The main emphasis, however, should be to fertilize the immediate crop with optimum application and most of the nutrients will be used by that crop, with relatively small amounts of residue left for the following crop.

Climatic Conditions

Climate is, perhaps, the most important factor influencing the soil and the crops growing on it. Temperature and precipitation exert profound effects on the rates of reaction of the different physical, chemical, and biological activities in the soil. It is impossible to change the temperature over a wide area to affect these activities and ultimately the production of field crops. Moisture can be controlled somewhat by drainage and irrigation, but here, too, it is difficult to change the moisture in the soil over large areas. This is particularly true in the Prairie Provinces where precipitation is low and moisture is often a factor limiting production. The application of fertilizer under these conditions is often not economical. Generally speaking, fertilizer utilization is more satisfactory where there is optimum moisture. While crop yields have been increased by fertilizers in these drier areas, little or no response is obtained in dry years, or in the drier areas where moisture is the chief limiting factor of production.

FERTILIZER REQUIREMENTS FOR VARIOUS FIELD CROPS

No adequate fertilizer recommendation can be made for a crop without knowledge of the quantities of nutrients required by that crop. There is considerable variation in the nutrient-supplying power of the soils across the country and it is often difficult to assess them in this regard. On the other hand, plant analyses have shown what quantities of nutrients are required by different crops, providing a basis for fertilizer recommendations.

If the fertility status of a soil is to be maintained, the quantity of nutrients removed by cropping and leaching must be replaced. If it is to be improved, a quantity greater than that removed must be supplied. Table 1 contains information obtained from various sources on nutrient removal by some field crops.

Table 1.—Nutrients removed by Field Crops

Crop	Assumed yield per acre	Pounds of nutrients per acre			
		Nitrogen (N)	Phosphorus (P2O5)	Potassium (K2O)	Calcium (CaO)
Alfalfa	3 tons	140	35	150	90
Alsike clover	3 "	120	35	180	90
Ladino clover	"	180	40	200	75
Red clover	3 "	120	30	115	80
Millet	3 "	80	20	100	15
Timothy	3 "	65	30	110	16
Wheat—grain	40 bu.	50	22	15	
—straw	3,600 lb.	30	7	40	
Oats—grain	70 bu.	45	20	15	
—straw	3,500 lb.	22	8	65	
Barley—grain	50 bu.	50	50	15	
—straw	2,500 lb.	20	7	40	
Field corn—grain	75 bu.	70	30	20	
—clover	5,000 lb.	60	8	65	
Potatoes—tubers	600 bu.	125	45	180	
*Sugar beets	20 tons	100	40	140	
*Turnips	15 tons	75	30	135	
*Mangels	25 tons	100	50	160	

* Does not include above-ground portions. Total nutrients used by above-ground portions is often the same as quantities used by below-ground portions. Therefore, to produce the assumed yields indicated, almost double the amounts shown would be used.

It is very difficult to determine the kind and amount of fertilizer to apply to various soils to produce maximum crop yields. Many factors influence crop growth and they must be considered. They include temperature, moisture and light conditions, soil texture, drainage, chemical and bacterial activity, previous soil management, crop rotation and other factors. Chemical and biological methods have been developed to measure fertility levels in the soil. These are helpful in determining what fertilizer to apply, but are not reliable alone for diagnosing fertilizer needs. Field experiments conducted on various soil types have contributed much useful information. Soil surveys have been made in most areas which classify the soils on the basis of their various characteristics. All factors must be considered and used in making fertilizer recommendations.

As mentioned previously it is impossible to make recommendations applicable to all conditions in Canada. The recommended fertilizers for various crops listed in Table 2 are suggested only as a broad general guide. For specific recommendations a local Experiment Farm or Fertilizer Board should be consulted.

In general, grain crops require fertilizers relatively high in phosphorus and nitrogen. Legume crops require more minerals, and phosphorus and potassium should constitute a high proportion of the mixture. Grasses should receive fairly liberal amounts of nitrogen. Corn requires high nitrogen and phosphorus applications. Root crops of various kinds need ample amounts of phosphorus.

Clay soils generally are more fertile than sandy soils, and lower rates of fertilizer application are usually satisfactory. Sandy soils respond especially to nitrogen and potassium. More fertilizer is recommended in humid areas than in drier regions. Again these points are to serve as a general guide and more specific information should be obtained from local extension specialists and Fertilizer Boards.

Table 2.—General guide of fertilizer analyses and rates in various areas.

(For specific recommendations, consult local Fertilizer Boards)

Crop	Eastern Canada		Prairie Provinces		British Columbia	
	Analyses	Rate (lb./ac.)	Analyses	Rate (lb./ac.)	Analyses	Rate (lb./ac.)
Wheat, Oats, Barley—						
Not seeded, unmanured						
Clays and loams	4–24–12	300	11–48–0*	50–100	11–48–0	100
Sandy soils	6–12–12	700	16–20–0**	70–150	16–20–0	100–300
Seeded down unmanured						
Clays and loams	4–24–12	400	11–48–0	100	....	....
Sandy soils	2–12–10	900	16–20–0	150	....	....
Seeded down, manured						
Clays and loams	2–16–6	400	....	....	11–48–0	100
Sandy soils	2–12–10	500	....	....	16–20–0	100
Hay, Legume—						
Clay soils	0–12–12	600–800	16–20–0	150	6–30–15	150–300
Sandy soils	4–12–10	300	....	....	2–16–6	400
Hay grass—						
Clay soils	3–15–6	700	....	....	6–30–15	400
Sandy soils	5–10–13	500	....	....	8–10–5	400
Pasture, legume—						
Clay soils	0–12–12	500	16–20–0	150–200	6–30–15	150–300
Sandy soils	0–12–20	500	....	....	2–16–6	400
Pasture, grass—						
Clay soils	4–24–12	400	....	....	6–30–15	400
Sandy soils	5–10–13	500	....	....	....	....
Potatoes	5–10–13	800–1,200	11–48–0	200–250	6–30–15	600–1,000
Corn silage—						
Clay soils	2–16–6	500	....	....	8–10–5	500
Sandy soils	4–12–10	600	16–20–0	80–100	16–20–0	400
Corn, grain	....	....	16–20–0	80–100	....	....
Turnips—						
Clay soils	3–15–6	300–500	....	....	....	....
Sandy soils	3–15–6	500–700	....	....	....	....
Mangels—						
Clay soils	3–15–6	400–800	....	....	....	....
Sandy soils	5–10–10	400–800	....	....	....	....
Sugar beets	4–24–12	250	11–48–0	100	11–48–0	100

* Used on fallow areas.
** Used on stubble areas.

FERTILIZERS FOR MARKET GARDEN CROPS

Mineral Soils

In market gardening, the quality and yield of the products grown are determined largely by the rapidity of growth and development of the crops. Certain crops such as carrots and beets require a continuous supply of plant food throughout the growing season. With others, such as tomatoes, where early ripening is important, it is desirable to induce early rapid growth, which is slowed up later in the season to promote development and ripening of the fruit. For leafy vegetables and certain root crops which require a short season of rapid growth, quickly available fertilizers are the most valuable.

Well-rotted manure is important in market gardening, as a source of plant nutrients and organic matter. However, the declining supply of manure has led gardeners to depend more and more on commercial fertilizers for maintenance of plant food, and the utilization of garden refuse and green manure crops for the upkeep of soil organic matter. Whenever land is to remain idle after a short-season crop, it is good practice to seed a green manure crop. Even after long-season crops, it is often possible to seed a winter cover crop such as fall rye.

In general, no one fertilizer mixture will meet all conditions with all crops and, because of this, different fertilizer mixtures are recommended in the different areas. Some of the most generally useful commercial fertilizers at present readily obtainable are the 5-10-13, the 4-12-6 and the 3-18-9 mixtures. Under average soil conditions the 5-10-13 may be used in conjunction with green manure crops, but without barnyard manure, for many kinds of vegetables, provided it is supplemented as necessary with nitrogen in a readily available form such as nitrate of soda, ammonium nitrate or sulphate of ammonia. For very light soils or those known to be low in potassium, additional quantities in the form of muriate or sulphate of potash may be necessary. Also, for a tomato crop or other crops with high phosphorus requirements, additional phosphorus as in superphosphate and bonemeal may be necessary. Where a moderate quantity of barnyard manure is available, a 2-16-6 or a 3-15-6 will correct the low phosphorus content of manure and thus provide a fair balance of nutrients for most vegetable crops.

The introduction of more concentrated fertilizer mixtures has lowered the cost of a unit of plant food by decreasing bulk and freight costs. Many of the common mixtures are now offered in one or more of a series such as the following: 2-12-10, 3-18-15, and 4-24-20 and it will be noted that the major nutrients are present in a ratio of 1:6:5. In such a series, if 1,000 pounds of 2-12-10 per acre is recommended then only 667 pounds of 3-18-15 or 500 pounds of 4-24-20 are required per acre to give the same quantity of plant food.

The following recommendations for market garden crops are derived from publications prepared by the various Provincial Departments of Agriculture and available from them. For more detailed information regarding recommendations for specific crops, reference should be made to the most recent publication from a given area.

Ontario, Quebec and the Maritimes

Leafy vegetables such as cabbage, cauliflower, chard, lettuce and spinach, as well as cucumbers, onions, parsnips, beets, carrots, melons, squash and pumpkins, should give adequate yields when a 5-10-13 or a 5-10-10 fertilizer at rates of 800 to 1,200 pounds per acre is used without barnyard manure. Where 10 to 20 tons of manure can be used, the nitrogen in the mixture may be lower but the phosphorus should be higher and consequently a 3-18-9 or 3-15-6 mixture at the same rates might be better. The higher rates should be used on the lighter soils low in organic matter such as are found principally in the Maritime Provinces. These crops, particularly the leafy crops, respond to a side dressing of nitrogen during the season. It is suggested that 60 to 100 pounds of ammonium nitrate applied during the season is beneficial and often required to stimulate the rapid growth required in these crops.

Potatoes which require large quantities of nutrients, and a higher proportion of these during the period 50 to 80 days after planting, should be fertilized with 1,000 to 1,800 pounds of 5-10-13, 5-10-10 or 6-12-12 per acre or their equivalent. The higher rate is suggested for the light soils of the Maritime Provinces which are generally rather low in organic matter. When relatively large quantities of manure are available for this crop, a mixture higher in phosphorus, such as a 3-18-9 or a 3-15-6, might be used at the same rates of application.

Tomatoes and Peppers are also heavy feeders and respond well to phosphorus in particular. In the Ontario and Quebec areas 1,000 pounds of a 2-12-10 or a 2-12-6 mixture should be adequate. On the lighter Martime soils increase the proportion of nitrogen and the rate of application, using 1,500 to 1,800 pounds of a 3-15-6 as well as about 10 to 15 tons of manure per acre. With tomatoes, a high-phosphorus starter solution at the time of transplating is generally beneficial. Staked and early tomatoes should be side-dressed where necessary with 200 pounds of ammonium nitrate and 400 pounds of muriate of potash about the time the staked tomatoes have set the third cluster of blossoms.

Peas and Beans are not such heavy feeders as some of the other vegetable crops. Because of danger of damage to the seed by direct contact with fertilizer, it is advisable to apply the fertilizer a few days before planting. On Quebec and Ontario soils, the general recommendation is a 2-12-10 or a 4-12-6 mixture at 500 pounds per acre. The proportion of nitrogen and potash should be increased in lighter eastern soils; probably the same quantity of a 5-10-13 would be best.

Corn does well on a combination of barnyard manure and commercial fertilizers in which both phosphorus and potassium predominate. When 10 to 15 tons of manure are available, 800 to 1,000 pounds of a 3-18-9 or 3-15-6 are suggested for this crop. Without manure, higher quantities of nitrogen should be applied, for example a 4-12-6 or 5-10-13 mixture at rates of 600 to 1,000 pounds per acre. Corn generally responds well to a side dressing of fertilizer when 12″ to 18″ high, using 150 pounds of ammonium nitrate per acre on heavier soils and 150 pounds of ammonium nitrate and 50 pounds of muriate of potash per acre on the lighter soils.

Asparagus requires heavy fertilization. In preparation of the bed there is no danger of making the soil too rich by using barnyard manure. A soil deficient in organic matter should have heavy applications of manure worked in thoroughly and deeply. Generally, application of a fertilizer such as 5-10-13 is recommended at rates of 1,200 to 1,600 pounds per acre. When the bed is established, the use of 4-12-6 or 5-10-13 at 900 pounds per acre immediately after cutting is finished is recommended.

The Prairies

Significant crop responses have followed the application of commercial fertilizers containing nitrogen and phosphorus. Where manure is not available or available only in limited quantities, a fertilizer such as ammonium phosphate (11-48-0) may be used at rates of 150 to 200 pounds per acre. If manure in quantities of 10 to 20 tons per acre is available, 200 to 300 pounds of superphosphate should be ample for most soils and crops. These practices are satisfactory on the majority of the black earth soils. On soils that were wooded prior to breaking it might be better to use a complete fertilizer such as a 9-27-9 at a rate of 250 pounds per acre.

British Columbia

In the major market garden areas of British Columbia soil analyses show that most of these soils are well supplied with available nutrients except for nitrogen and boron. The general recommendation for most medium or heavy textured interior soils is to use 400 to 1,000 pounds of ammonium phosphate (16-20-0) per acre to obtain good crops of tomatoes, potatoes, cantaloupes, onions, root crops, and cabbage. On light sandy soils it is advisable to use 800 to 1,000 pounds of 8-10-5 per acre. For leafy crops, such as lettuce and spinach and for corn and asparagus, ammonium nitrate is recommended at rates varying from 200 to 350 pounds per acre.

General Trace Element Consideration

Except under special circumstances, the so-called minor or trace elements, boron, copper, iron, manganese, molybdenum and zinc need not be applied. There is sufficient of these in most soils and their use may do more damage than good to the crop. In some cases, however, minor elements are needed to promote optimum yield and quality of crop. Celery, turnips, beets and cauliflower must in certain areas receive boron applications in order to give satisfactory growth. Manganese must be added in a few instances for certain vegetable crops including beans, and magnesium is required on a number of crops particularly in New Brunswick. However, extreme care should be taken in the correction of any suspected minor element deficiency. Growers are referred to the Provincial Board recommendations and are advised that applications should be made only under expert guidance.

Organic Soils

Organic soils may be divided into two groups, muck and peat. With muck soil, the top layer of six inches to a foot is well decomposed. With peat, decomposition has not progressed so far and the original plant remains are visible in the surface layer. On the latter type, success in crop production depends largely upon the degree of decomposition of the soil. Raw or undecomposed peat is of little value for crop production, but, as decomposition progresses, the value increases. Application of up to 10 tons of well-rotted barnyard manure along with high-potash fertilizer has hastened decomposition and release of plant food and improved the physical condition of peat soils. Such treatment inoculates the soil with bacteria and at the same time provides nutrients so that the micro-organisms increase and hasten decomposition of the peat. When the point has been reached where further response in crop yields cannot be obtained from application of manure, the surface will have reached an advanced stage of decomposition which may, from a practical standpoint, be considered as muck and treated accordingly.

With very acid peat, where the pH value is from three to five, lime is essential for successful crop production. The amount required will vary from 3 to 10 tons of ground limestone per acre according to the degree of acidity. Since there is little downward movement of solutions in this soil type, about one-half of the application should be plowed in to a depth of 10 or 12 inches and the remainder worked in from the top. This will provide a zone with a corrected pH value deep enough for satisfactory root development.

In the use of fertilizers on organic soils that have been cropped for several years, applications in excess of crop requirements should be avoided. The normal mineral content is low and the loss by leaching small. As a result, the residue from excessive application may remain in the soil and upset the balance of mineral nutrients to the extent that actual deficiencies may occur.

This has been noted in several instances where an excess of potassium, built up by heavy applications of a fertilizer high in this nutrient, has resulted in severe magnesium deficiency and consequent crop loss. However, potassium is generally the most important element in plant nutrition on these soils and its need is usually apparent on newly broken areas. Where potassium-hungry crops such as celery and potatoes are grown on newly broken land, applications of muriate of potash, up to 200 pounds per acre, may be required in addition to the recommended application. Sulphate of potash has not been found satisfactory for typical organic soil in Eastern Canada. Usually after applying extra potassium for two or three years the deficiency will have become corrected and the normal recommendation will prove satisfactory.

Although the mineral content of these soils is low, nitrogen is correspondingly high and may run to a total of 40,000 pounds per acre-foot. In the natural state it is in an unavailable form but is made available by microflora in the soil, which, in turn, are increased and activated by a balance of mineral nutrients. With this vast reserve of soil nitrogen, fertilizer applications should be such that mineral nutrients are supplied to meet crop requirements, but most of the nitrogen required by the crop is made available by nitrification in the soil. However, these soils warm up slowly in the spring and the release of nitrogen is usually inadequate for early crops until warm weather sets in. Accordingly, in spring applications of fertilizer, a moderate amount of nitrogen is necessary to keep crops growing until a supply from the soil is available. Also, during extremely cool, wet seasons, when soil nitrification is slow, side applications of sulphate of ammonia or ammonium nitrate at rates up to 150 pounds per acre may be necessary.

Table 3.—Summary of Fertilizer Analyses Recommended for Organic Soils *

Crop	Rate per acre	Peat and acid muck	Muck	Alkaline muck
	lb.	pH below 5	pH 5–7	pH 7.1–8.5
Asparagus	400– 800	Unsuitable	2– 8–16	2– 8–20
Beans	300– 600	3–12–16	0– 8–16	0– 8–20
Beets (table)	500– 800	3–12–16	2– 8–16	2–12–20
Broccoli	500– 800	3–12–16	2– 8–16	2–12–20
Cabbage	600–1,000	2– 8–16	2– 8–16	2–12–20
Carrot (table)	500– 800	5–10–13	2– 8–16	2– 8–20
Cauliflower	800–1,200	5–10–13	2– 8–16	2–12–20
Celery (early)	1,200–1,800	Unsuitable	2– 8–16	2– 8–16
Celery (storage)	1,200–1,800	Unsuitable	2– 8–16	2–12–20
Cucumber	400– 800	2– 8–16	0– 8–16	0– 8–20
Lettuce	600–1,000	3–12–16	2– 8–16	2–12–20
Muskmelon	400– 800	3–12–16	2– 8–16	2– 8–20
Mint	200– 400	2– 8–16	2– 8–16	2– 8–20
Onion	1,000–1,500	3–12–16	2–12–10	2–12–20
Parsnip	600–1,000	3–12–16	2– 8–16	2–12–20
Pea	400– 700	3–12–16	2–12–10	2– 8–16
Pepper	800–1,500	5–10–13	2– 8–16	2– 8–20
Potato	1,000–1,500	3–12–16	2– 8–16	Unsuitable
Pumpkin	300– 600	2– 8–16	0– 8–16	0– 8–20
Radish	500–1,000	5–10–13	2– 8–16	2– 8–16
Spinach	600–1,000	3–12–16	2– 8–16	3–12–16
Squash	300– 600	2– 8–16	0– 8–16	0– 8–20
Sweet corn	400– 800	Unsuitable	2– 8–16	0– 8–16
Tomato	500–1,000	3–12–16	0– 8–16	0– 8–20
Turnip (Swede)	600–1,000	5–10–13	2– 8–16	2– 8–20

*Based on experiments at the Organic Soils Substation, Sainte-Clothilde, Que.

Other Considerations

On very acid, raw peat, nitrogen up to 5 per cent in the fertilizer mixture may be necessary for the first year or two after breaking.

On shallow muck soils that have been in cultivation for a relatively long time and whose organic layer has become reduced in depth to less than one foot, more nitrogen and less potash is required in the fertilizer application. For such conditions the recommendations for peat and acid muck should be followed.

Copper is essential for many crops on organic soils. Of these, onions seem to demand the most and, in some instances, applications of 100 to 150 pounds of copper sulphate per acre have given positive results. On reclaimed land that has been wholly or partly under water, applications up to 200 pounds have been found necessary for the first year. However, on normal muck or peat, yearly applications of 30 to 50 pounds of copper sulphate per acre have been found sufficient for copper-hungry crops, such as onions, spinach, and carrots. For other crops, where a copper deficiency exists, similar amounts applied every second or third year should prove sufficient. Where potatoes and celery are sprayed or dusted with materials containing copper, such as bordeaux mixture and fixed copper, no additional copper is needed. Moreover, the residue left in the soil after several crops of celery or potatoes, will be sufficient for most crops for one or two years.

Where boron deficiency is known to exist, applications of 15 to 20 pounds of borax per acre apparently suffice for most crops. With celery, up to 40 pounds per acre may be required for one year with annual applications of 20 pounds. When sprayed on the foliage with bordeaux or fixed copper, one-half of the amount required for a soil application will correct the deficiency for one year only. The customary rate is 5 pounds of borax to 100 gallons of spray included in two or three applications. For alkaline muck, where boron is deficient, the rate for soil applications should be increased by 50 per cent. Boron should not be applied unless the need for it has been indicated, since an excess in the soil is toxic to plants.

Manganese deficiency in normal muck or peat can usually be corrected for such crops as spinach, cabbage, cauliflower, broccoli and beans, by a soil application of 40 to 50 pounds of manganese sulphate per acre every second or third year. For celery, annual applications may be necessary. On alkaline mucks at least double this amount may be required. Where the soil is very acid, manganese should not be applied until deficiency symptoms are exhibited by the crop. Even then, the rate of application should not exceed 10 or 15 pounds of manganese sulphate per acre. On such soils an excess of manganese may induce toxicity, the cause of serious disorders such as "potato stem streak". In general, applications of manganese sulphate applied as a spray on the foliage are more effective than soil applications. From one-third to one-half of the amount required for a soil application will correct the deficiency for one year. It can be applied alone in water or combined with copper sprays at 10 to 12 pounds per 100 gallons of liquid.

FERTILIZERS FOR SMALL FRUITS

Both bush fruits and strawberries require a soil high in organic matter and retentive of moisture. Unless the soil is naturally well supplied with humus, it is necessary to build up the supply for a year or two previous to planting.

Barnyard manure, green manure crops or mulch, for example hay or straw, must be the basis of the soil fertility program. Maintenance of fertility in a raspberry or strawberry plantation is simple if plenty of barnyard manure is available. Where manure is not available, it is necessary to resort to the use of green manure crops or mulch. Commercial fertilizers are beneficial as a supplement.

Strawberries

In the spring of the year previous to planting, apply 20 tons of manure or 6 tons of hay and straw top-dressed with 150 pounds of ammonium nitrate. During this year, plant a green manure crop with 600 pounds of 0-12-20 per acre or, as an alternative, a well-manured and fertilized row or hoed crop can be planted. If such a crop is planted, it would probably be advisable to apply 500 to 1,000 pounds of a 5-10-13 or 5-10-10 fertilizer per acre to the area during the year the strawberry crop is planted.

The fertilizer can be applied at least ten days before planting but, because of the possibility of damage to the plants at this stage, it might be advisable to delay this application of fertilizer until one month after planting or until the plants have become established.

In all cases in late summer, that is, late August and early September, two applications of sulphate of ammonia or equivalent, each of 100 pounds per acre, should be made two weeks apart to stimulate the formation of fruit buds.

Bush and Cane Fruits

On a normal or well-balanced soil, the supply of nitrogen appears to be the main factor limiting growth and fruitfulness.

1. Apply barnyard manure, 15 to 20 tons per acre, previous to setting out the plantation. Annual applications should be made thereafter in late fall or early spring; the rate of application varying with the needs of the plantation as evidenced by growth, fruitfulness, and hardiness.

2. When manure is not available, green manure crops should be grown in advance of planting and annually thereafter during the life of the plantation. Even if manure is available it is good practice to seed a winter cover crop such as fall rye, shortly after the raspberry crop is harvested. Supplement annually with a complete commercial fertilizer applied in early spring, at the acre rate and the approximate proportions of: 320 lb. sulphate of ammonia, 180 lb. 20 per cent superphosphate, 100 lb. muriate or sulphate of potash; equivalent to 700 lb. of a 9-5-7.

FERTILIZERS FOR TREE FRUITS

Quebec and Eastern Ontario

An adequate supply of organic matter, whether as barnyard manure, green manure crops, or mulch material such as hay or straw, must form the basis of the orchard soil management program. The following fertilizer recommendations should, therefore, be regarded as supplementary to a satisfactory organic matter content in the soil. No good rule-of-thumb method for yearly and general fertilizer applications can be made. It is only by watching growth and foliage appearance that growers will ultimately maintain an approximately correct fertilizer relationship.

In most orchards the application of the minerals separately from the nitrogen is good practice. A lack of nitrogen is quickly expressed by the tree in the form of light green foliage and restricted growth and, fortunately, this condition is easily corrected by the application of a readily available nitrogenous fertilizer. It is safer to supply a large amount of nitrogen to a soil known to be well stocked with mineral nutrients than to one that may be low in these elements. With yearly applications of mineral fertilizers, nitrogen may be employed as a balancer, using the foliage and growth characters to indicate whether a heavy or light application should be made. Ordinarily 400 lb. of ammonium sulphate per acre or its equivalent would be considered a moderately heavy application and should be employed only on soils not high in nitrogen. An application of 300 lb. would be a mederate one. If the available mineral content of the soil is high, the heavier application would be satisfactory; if low, it might do as much harm as good.

Since many orchards are not solidly planted and contain trees of different ages, growers often prefer to apply the fertilizer only to the soil area occupied by the tree roots. An application of ¾ lb. of ammonium sulphate for each inch of trunk diameter or ⅕ lb. for each year of tree age would constitute a moderately heavy application. Orchards in sod generally require heavier applications of quickly available nitrogen than orchards that are cultivated. This is especially true in areas where the mulch material does not decompose rapidly owing to the lack of sustained adequate moisture. On the other hand, the maintenance of organic matter, the source of more slowly available nitrogen, is more difficult in cultivated orchards. Decomposition of organic matter often occurs at such a rate and at such a time that the trees are unable to make full use of the liberated nitrogen and considerable loss occurs through leaching and erosion.

To accomplish its purpose nitrogen should be applied early in the spring well in advance of tree growth. On cultivated orchards mineral fertilizers should be applied either in the spring or fall at a time when it is possible to work the soil immediately.

The following annual applications are suggested on soils that are at present producing satisfactory results without any foliage symptoms indicating lack of any individual element:

1. Use 200 lb. of 20 per cent superphosphate per acre, 125 lb. of either sulphate or muriate of potash per acre and nitrogen as needed and in the form preferred by the grower. On alkaline soils, use a nitrogen fertilizer with residual acid reaction, such as sulphate of ammonia.

If it is desirable to apply the fertilizer only to the soil area occupied by the tree roots, use ½ lb. of 20 per cent superphosphate and ¼ lb. of sulphate or muriate of potash per inch of trunk diameter.

2. Where a complete fertilizer is desired, a 9-5-7 or 10-5-10 is suggested at the rate of 500 to 700 lb. per acre or 1 to 1½ lb. per inch of trunk diameter. This should be considered as a maintenance fertilizer on soils in which the plant foods are in a well-balanced condition.

3. Where leaf scorch due to potassium deficiency is present, eliminate the nitrogen for a season at least and rely solely upon minerals, applying superphosphate at 200 lb. per acre and sulphate or muriate of potash at 350 to 400 lb. per acre until the deficiency is corrected. On such soils a 5-10-13 should prove a good maintenance fertilizer.

4. Where manure is available it may be employed successfully. On the average, most barnyard manure is about correct in its proportion of nitrogen, phosphorus, and potassium for orchard use. Annual applications of 6 to 7

tons per acre should be sufficient to provide the equivalent of 700 to 800 lb. of a 9-5-7 or 10-5-10. Since the nitrogen in manure is rendered available rather slowly it may be necessary to supplement manure with a quickly available nitrogenous fertilizer early in the spring. Excessive quantities of manure may delay the trees hardening off in the fall, thus rendering them susceptible to winter injury.

Maritime Provinces

For general use in Maritime orchards it is suggested that a 9-9-7-1B or a 12-5-7 mixture be used according to soil and crop requirements. The usual rates are from 400 to 900 pounds per acre, as indicated by terminal growth. On soils that are very acid, dolomitic limestone, supplying both calcium and magnesium, should be used at rates up to 2 tons per acre. For soils low in phosphorus, 6-12-6 or 3-15-6 should be substituted and, where potassium is required, a 5-10-10 or 6-9-12 would be suitable.

British Columbia

In most British Columbia orchard areas, the control of nitrogen levels and certain of the micronutrient element deficiencies are the main considerations. The general recommendation for the area requires the application of sufficient ammonium nitrate in late fall to give proper tree vigor as indicated by an annual shoot growth of 10 inches with mature apples. Greater growth is desirable with young trees. Shoot growth is measured on leading terminals growing outwards at an angle around the periphery of the tree.

Control Measures for Orchard Trace Element Deficiencies

In orchards in general, the main problems are in the control of nitrogen, phosphorus, potassium, and calcium levels and, of these, nitrogen and potassium in particular tend to become readily deficient. Barnyard manure, commercial fertilizers, and ground limestone usually overcome such deficiencies when applied at recommended rates.

Of the remaining elements, most are sufficiently available for normal growth. Under certain conditions, however, additions of boron, magnesium, zinc, and manganese may be necessary with boron and magnesium deficiencies being problems in most producing orchards.

Control Measures for Cork Disorders Due to Boron Deficiency

Although not directly responsible, the soil moisture condition is probably a deciding factor as to whether such troubles will reach serious proportions in a given season. Unfortunately it is not possible to forecast when such unfavorable conditions will occur.

Boron should be applied in either the early spring or fall to orchards in any area where cork has been found and where no application of boron has yet been made.

Orchards on Acid Soils.—Apply 4 ounces of borax to trees up to 10 years of age, 8 ounces to trees from 10 to 20 years of age, and 8 to 16 ounces to older trees. If boric acid is used, the rates should be two-thirds of those mentioned. To apply this small quantity, the borax or boric acid may be mixed with several times its volume of dry sand or soil as an aid in spreading. In the Maritime Provinces, orchard fertilizers are available with 1 per cent borax which will meet the boron requirement. In British Columbia, it is recommended that an application of 30 pounds of boric acid be broadcast on the soil every three years. On very light soils, this should be an annual application of 10 pounds of boric acid per acre.

Orchards on Alkaline Soils.—If the soil is alkaline and high in calcium carbonate, effective control may not be obtained by applications to the soil in a season of very low soil moisture. Under these conditions more effective control may be obtained by incorporating borax with the regular spray. The soil application may be supplemented by employing borax in two early sprays at the rate of 2½ pounds to 100 gallons of spray.

The foregoing recommendation should not be considered as annual treatments since there is the possibility of creating toxic concentrations of boron. A single treatment has been found effective for a period of three years under fairly normal conditions. The safest procedure would be to forego further applications until the disorder again makes its appearance.

In British Columbia it is recommended that all trees be sprayed each season with 5 pounds of soluble boron per acre in concentrate sprayers as soon as the leaves are well developed.

Control of Magnesium Disorders

Magnesium deficiency has become fairly widespread in the eastern areas of Canada as well as in the far western fruit growing areas. In many instances it is only of an incipient nature, not causing any serious defoliation; in other instances almost complete defoliation may occur by late August, especially in wet years. In such cases a dry season may almost completely remove the trouble for that year. Generally, it is much more acute on strongly acid, low lime soils and under these conditions it is difficult to control by soil application.

Orchards on Acid Soils.—Apply dolomitic limestone at the rate of two tons to the acre. It may be necessary to repeat this treatment at two-year intervals. This is not a quick remedy; from three to five years may elapse before any marked recovery can be noted. In addition to the above, in order to obtain immediate relief, the use of magnesium sulphate in the cover sprays is recommended. For this purpose, 20 pounds of magnesium sulphate should be added to every 100 gallons of the regular spray solution, starting with the calyx spray and repeating with the first two cover sprays.

Orchards on Neutral and Alkaline Soils.—On soils that are not decidedly acid (pH 6·5 or above) soil applications of magnesium sulphate, worked into the soil, may give early response, if applied at the rate of 12 pounds per tree. If this does not give response in the year of application, the spray method may be employed for a few years.

Control of Zinc Disorders

Only in the Okanagan Valley of British Columbia has a deficiency of zinc become a commercial problem on tree fruits. It is recommended that dormant sprays of zinc sulphate be applied at a concentration of 20 pounds per 100 gallons of water or 40 pounds per acre applied by concentrate sprayers during the late dormant period, i.e., just before the buds break and the green tips appear. One application may prevent the deficiency in some orchards, while in others further applications in following years may be required.

FERTILIZERS FOR TOBACCO

Considerable quantities of chemical fertilizers are required for the commercial production of tobacco. The kind of fertilizer and the rates of application vary with the type of tobacco grown and the nature of the soil used for each type of tobacco. Economical use of fertilizer is associated with the relative soil fertility, organic matter content, use of manure, soil reaction, cultural methods, incidence of disease, and general practices of soil management. These factors should be considered in determining the fertilizer mixture and the rate of application to use for a specific type of tobacco.

Commercial fertilizers are applied to the tobacco crop for the purpose of supplementing and balancing the plant food of the soil. Much of the soil plant food is contained in the organic matter portion which is supplied by green-manure crops, by crop residues including straw and stalk material, or by farm manure. These sources of organic matter are vitally important in conserving plant food for use in crop production. Crop rotations, which include winter cover crops, are recommended to provide organic matter, reduce leaching of plant nutrients and prevent water and wind erosion of tobacco soils.

Sources of Commercial Tobacco Fertilizer Materials

Special attention is required in choosing materials for making commercial fertilizer mixtures for tobacco chiefly in respect to the contents of nitrogen, phosphorus, potassium, chlorine, magnesium and calcium.

Sources in Ontario

Results of experiments in Ontario indicate an advantage in using more than one source of nitrogen. Approximately one-quarter of the total nitrogen should be in the nitrate form and the rest in standard water-soluble materials. Phosphorus should be derived from superphosphate or some other easily soluble form of phosphate. The potassium may be supplied in the form of sulphate of potash or a combination of sulphate and muriate of potash. While a portion of the potassium may be supplied from water-soluble sources other than the sulphate, the fertilizers containing 30 units or less of plant food should contain a minimum of 2 per cent and a maximum of 3 per cent chlorine. For fertilizers containing more than 30 units of plant food a minimum of 3 per cent and a maximum of 4 per cent chlorine is recommended. To prevent magnesium deficiency, tobacco fertilizers containing 30 units or less of plant food should contain 40 pounds of magnesium (25MgO) per ton while fertilizers containing more than 30 units should contain 60 pounds.

Sources in Quebec

The source materials for nitrogen and phosphorus in Quebec are the same as those recommended for Ontario but the potassium and magnesium sources are different as follows:

For cigar tobacco, the source of potassium should be sulphate of potash only and the fertilizer mixture should be free of chlorine, because chlorine has an adverse effect on the burning quality of cigar tobacco. For flue-cured tobacco, a portion of the potassium may be supplied from water-soluble sources other than the sulphate but the chlorine content in fertilizer mixtures of 30 units or less should be not less than 2 per cent and not more than 3 per cent.

All tobacco fertilizer mixtures of 30 units or less should contain 2 per cent magnesia (MgO) with not more than 0·5 per cent water-soluble magnesia (MgO). In addition, for flue-cured tobacco, an application of a mixture containing 65 pounds of dolomitic limestone (20 per cent MgO), 80 pounds of kieserite (16 per cent MgO) and 55 pounds of sand is recommended. This mixture should be broadcast early in the spring before planting tobacco once every two years in the two-year, rye-tobacco rotation.

Fertilizers for Tobacco Seedbeds

Fertilizers should be spread uniformly on the seedbeds and raked into the surface layer after steaming or sterilizing the beds. An excessive amount of fertilizer, particularly nitrogen, in the bed is a common cause of seedling injury. Only commercial fertilizers low in chlorine should be used at the following specified rates of application:

(1) For Ontario flue-cured, burley, and dark varieties: One bag (80 pounds) of tobacco fertilizer containing 2 to 3 per cent nitrogen, to 800 to 1,000 square feet of bed or approximately 1 pound of fertilizer per square yard mixed with muck before seeding has given good results. Under ordinary circumstances, when this application is made no additional fertilizers are required in the seedbed.

(2) For Quebec flue-cured, cigar, and pipe varieties: Where a muck-manure compost is used for the surface layer in the bed, from 3 to 5 pounds of a commercial tobacco fertilizer per 100 square feet are recommended but where virgin muck is used alone (without manure) 6 to 10 pounds are recommended. The 2-12-10 commercial fertilizer mixture is generally used for flue-cured varieties and the 5-8-10 for cigar varieties. Rates higher than 10 pounds per 100 square feet are excessive and usually cause seedling injury.

Fertilizers for Tobacco Crops in Ontario

Methods of Applying Commercial Fertilizers

The fertilizer is best applied in Ontario at transplating time in bands about 4 inches on each side of the row and on a level with or slightly below the root crown (3 to 4 inches deep.) This is accomplished by the use of a fertilizer attachment on the transplanting machine. If the fertilizer is applied in the row before planting it should be thoroughly mixed with the soil one week to ten days before transplanting in order to avoid fertilizer burn. If this fertilizer is applied with a grain drill attachment for burley tobacco it should be drilled 3 to 4 inches deep a few days before planting. Side dressing part of the fertilizer application after planting depends somewhat on the local condition. The production of export or heavy bodied burley especially on sandy loam soils usually responds well to applying half the fertilizer in bands at planting and the remainder as a side dressing ten days to two weeks after planting. Applying the total quantity of fertilizer in one application at the time of planting is recommended for flue-cured and cigarette burley types. The broadcasting of fertilizer followed by disking is a wasteful practice and is not normally recommended in Ontario.

Flue-Cured Tobacco

Flue-cured tobacco soils are classified as sandy soils and fairly light loam soils, with sand ranging from 60 to 90 per cent and organic matter from 1·0 to 2·5 per cent. Their low natural fertility requires careful management and well-balanced fertilizers for the production of flue-cured tobacco. It is important to conserve the soil organic matter by a system of crop rotation and fertilization in which all valuable plant food materials are disked or plowed back into the soil. Flue-cured tobacco in Ontario is generally grown after winter rye. The land is rested from tobacco at least eighteen months in a two-year crop rotation with rye as the intervening rest crop. Exceptions to this rule naturally exist, especially in districts where early cash crops on sandy soil are grown extensively and become a part of the flue-cured tobacco crop rotation. Fertilization of the rye crop with nitrogen or a complete fertilizer is now recommended to replace barnyard manure in the flue-cured tobacco crop rotation. It is recommended that 75 pounds of ammonium nitrate per acre or its equivalent be applied on the young rye as growth starts in the spring and that 60 pounds of ammonium nitrate per acre or its equivalent be applied when the mature rye is disked into the soil early in August. If the soil is low in potassium, 100 pounds of muriate of potash should be applied in addition to the nitrogen when disking in the mature rye crop. An alternative would be to apply 75 pounds of ammonium nitrate on the rye in the spring and 200 pounds of a complete fertilizer high in nitrogen such as a 10-5-10 when disking the mature crop of rye. This is a general recommendation. The exact amount of nitrogen required should be determined by the past performance of the soil in question.

Direct Fertilization for Flue-cured Tobacco

In recent years extension of flue-cured tobacco production in Ontario to new regions, increasing use of supplemental irrigation, new varieties and new information regarding fertility practices, now requires several fertilizer analyses to meet as far as possible the over-all needs of the flue-cured tobacco growing industry in Ontario. These analyses are designated as follows: 2-12-10; 3-18-15; 2-10-15; 3-15-20; 2-18-18, and 0-12-20.

The 2-12-10 and 3-18-15 analyses are recommended for present varieties grown under average conditions where the potassium in the soil is at a satisfactory level. The 3-18-15 analysis is merely 1½ times the strength of 2-12-10, therefore 666 pounds of 3-18-15 is equivalent to 1,000 pounds of 2-12-10 per acre. Under normal conditions 1,000 pounds of 2-12-10 is sufficient to grow good quality and yields of tobacco. Variations from 800 to 1,200 pounds per acre may be necessary depending on soil conditions and previous fertilizations.

The 2-10-15 analysis is recommended for soils low in potassium. High levels of potassium are necessary to obtain high yields of good quality leaf. An application of 1,000 pounds of 2-10-15 per acre provides 150 pounds of potash, whereas 2-12-10 at the same rate provides 100 pounds of potash. At the Delhi Substation, 120 to 140 pounds of potash per acre have given optimum results both in quality and yield.

The 3-15-20 analysis is approximately one and one-half times the strength of the 2-10-15 and if applied at approximately 700 pounds per acre will be about equal to 1,000 pounds of a 2-10-15.

The 2-18-18 analysis, applied at the rate of 600 to 700 pounds per acre, is recommended for the heavier soils and on soils with high levels of nitrogen, especially where delayed maturity has been experienced. The 2-18-18 analysis at 700 pounds per acre provides 14 pounds of nitrogen, 126 pounds of phosphoric acid, and 126 pounds of potash, whereas 2-12-10 at 1,000 pounds provides 20 pounds of nitrogen, 120 pounds of phosphoric acid, and 100 pounds of potash. In other words, 2-18-18 supplies less nitrogen but more potash than 2-12-10 at the above rates. The 2-18-18 analysis will take the place of both 2-12-10 and 0-12-20 on soils that tend to produce late maturing crops. The rate of application of 2-18-18 must be closely adhered to, since high rates may delay maturity in the same manner as do high rates of 2-12-10.

The 0-12-20 analysis is recommended for special cases such as on low areas where the nitrogen levels are often high, or on areas that have been heavily infested with vetch. The 0-12-20 analysis should be broadcast prior to transplating at about 200 pounds per acre. This analysis helps to hasten maturity only when complete tobacco fertilizers are not applied in excessive amounts.

Burley Tobbaco

Burley tobacco soils are classified as either sandy loam, gravelly loam, or clay loam. Generally speaking they contain more silt, clay and organic matter, and are relatively more fertile than the flue-cured tobacco soils. Since burley tobacco soils vary a great deal in type and fertility the fertilizer program should be regulated accordingly. The use of cover crops, barnyard manure, crop residues, and the inclusion of soil building crops such as legumes in three- and four-year crop rotation systems, are recommended along with commercial fertilizers.

Burley tobacco responds readily to commercial fertilizers. The quantity of plant food required depends somewhat on past performance of the soil, and whether or not cigarette or export burley is grown. For instance, the practice of close planting and high topping recommended for cigarette burley requires a somewhat heavier fertilizer application than the practice of wide spacing and low topping for export burley. The range in rates of fertilizer per acre specified below, therefore, is in consideration of the kind of burley grown. The higher rate per acre is recommended for cigarette burley, whereas the lower rate is recommended for export burley. The use of supplemental irrigation, when properly applied, appears to make little or no additional demand on fertilizer materials for burley tobacco above amounts normally recommended for non-irrigated tobacco crops.

1. For soils of light texture, such as sandy loam and gravelly loam, a 5-10-15 fertilizer mixture should be applied at the rate of 1,200 to 1,500 pounds per acre.

2. For soils of a heavy texture such as clay loam and dark loam, either a 2-12-10 or a 3-18-15 fertilizer mixture should be applied at the rate of 800 to 1,200 pounds per acre.

Dark Tobacco

Dark tobacco responds best on silt loam and clay loam soils that are well fortified with soil organic matter. The proper maintenance of soil organic matter in these closer textured soils provides for steady growth in dark tobacco necessary to produce proper leaf thickness, elasticity and dark brown color of leaves of a wrapper quality. The high content of organic matter is maintained by heavy applications of manure and by plowing down alfalfa and sweet clover used in a crop rotation system of four to six years' duration. A 5-10-15 fertilizer is recommended for dark tobacco. The rate of application may vary from 500 to 1,000 pounds per acre depending on the general level of soil nutrients, quantity of manure applied, and the method of applying the fertilizer. A general practice among growers is to apply half the fertilizer with a grain drill attachment before planting the tobacco and the remainder as a side dressing two to three weeks after planting. In such cases 1,000 pounds of fertilizer is recommended for best results.

Fertilizers for Tobacco Crops in Quebec

Methods of Applying Commercial Fertilizers

As a general rule, fertilizer should be placed so that it does not come into direct contact with roots of newly-set plants. For all types of tobacco grown in Quebec, fertilizer should be applied to well-harrowed soil, by the method of either band application or row application. When the planting machine is equipped with a fertilizer attachment, the fertilizer is spread at planting time in two bands about 7 inches apart and about 1 inch below the roots of the plant 3 to 4 inches deep. When fertilizer is drilled in the row before planting, care should be taken to mix it well with the soil about one week before transplanting to avoid fertilizer burn. Shallow placement of fertilizer should be avoided. For cigar and pipe tobacco, the broadcasting of fertilizer a few days before planting will give good results if ridging is practised before planting in order to bring the fertilizer close to the rows.

Flue-cured Tobacco

In Quebec flue-cured tobacco soils, a 2-12-10 analysis should be applied to the tobacco crop at the rate of 800 to 1,100 pounds per arpent, according to soil fertility. When the soil is low in potassium, a broadcast application of 80 pounds of sulphate of potash before planting is recommended in addition to the regular fertilization. For soils high in nitrogen and organic matter, where late maturity has been experienced a broadcast application of 200 pounds of 0-12-20 before planting is recommended, in addition to the regular 2-12-10 analysis used at the rate of 800 pounds per arpent.

The above recommendations are made for flue-cured tobacco grown in a two-year rotation, tobacco-winter rye, and assumes the disking under of a crop residue of mature straw and a green manuring crop in order to maintain the supply of organic matter and the productivity of flue-cured tobacco soils.

Winter rye should be sown, after a light harrowing, with a grain seeder (1½ bushels per arpent) as soon as possible after the tobacco crop is harvested.

The rotation which includes one mature crop followed by a green manuring cover crop of the Horton or other good variety of winter rye is especially recommended. If the rye crop is not well developed, the entire mature crop of rye may be disked in the soil for automatic reseeding. If the rye crop is well developed it might be either harvested with a combine or disked for automatic reseeding. In both cases, it is important to disk the mature straw back into the soil with either fertilizer or about four tons of manure per arpent. When fertilizer is used, nitrate of ammonia at the rate of 100 pounds per arpent should be broadcast at the time of disking in the rye straw early in August. If the soil is low in phosphorus and potassium, the ammonium nitrate can be replaced by a 10-5-10 fertilizer at the rate of 300 pounds per arpent.

As an alternative, on light infertile soils low in organic matter, ammonium nitrate at the rate of 65 pounds per arpent should be applied in the spring on the young rye following tobacco, to increase the yield of straw and grain. In this case, the application of manure or fertilizers on rye straw in August should be reduced to one-half of the amounts given in the preceding paragraph. On very productive soils, neither fertilizer nor manure should be applied to the rye straw, as there is apparently enough nitrogen in the soil for decomposition of the straw.

Cigar and Pipe Tobaccos

Cigar tobacco in Quebec is grown on a wide range of soils which include the relatively infertile uplands sandy soils, the more fertile sandy loams, the loams and clay loams, and the highly fertile lowland Yamaska Valley (alluvial) soils. In general, the system of long rotations of four, five or six years and the extensive use of barnyard manure are recommended in addition to the use of commercial fertilizers on all soils, except the very fertile lowland river soils of the Yamaska Valley which require only manure and fertilizer each year for continuous tobacco cropping.

These soils are somewhat low in potassium. Since this element is highly beneficial to the burning quality, the fertilizer mixture for cigar tobacco should contain at least 10 per cent of potash. In addition, in order to improve the burn of cigar tobacco, growers should not use muriate of potash to fertilize crops grown in rotation with cigar tobacco because the muriate form contains chlorine, considered to be detrimental to the burning quality.

(1) For sandy loam soils and sandy soils: On these, which include the majority of the cigar tobacco soils in Quebec, a 5-8-10 fertilizer mixture applied at the rate of 1,000 pounds per arpent in addition to 12 to 15 tons of manure is recommended.

(2) For loam and clay loam soils: On these relatively heavy and more fertile soils, a 5-8-10 mixture at the rate of 700 to 1,000 pounds per arpent with 12 tons of manure should be applied.

(3) For fertile lowland (alluvial) river soils: On highly fertile lowland soils along the Yamaska River, a 5-8-10 mixture at the rate of 500 to 700 pounds per arpent with 10 to 12 tons of manure is recommended.

Fresh barnyard manure should be applied preferably in the fall before plowing. Well-rotted manure should be applied in the spring and disked into the surface soil. Manure, clover, alfalfa, and small-grain crop residues are important sources of soil organic matter which is essentially rich in available plant food. When the above recommended quantities of fertilizer and manure are applied to the cigar or pipe tobacco crop, the other crops grown after tobacco in a rotation do not require fertilization. The grower should, therefore, select one of the following rotations to suit his own particular soil conditions:

4-year rotation: Cereal-hay-tobacco-tobacco

5-year rotation: Cereal-hay-tobacco-tobacco-tobacco

6-year rotation: Cereal-hay-pasture-tobacco-tobacco-tobacco

In the first year of each rotation system, a crop of oats or barley is seeded with a hay mixture which contains mostly clover and alfalfa. This crop is harvested. In the second year, the hay is harvested once and the aftermath is plowed under before winter sets in, except in the six-year rotation which includes one year of pasture following hay. When the aftermath of clover and alfalfa is plowed under, it serves as a green manure to supply valuable soil organic matter and plant food; consequently an application of manure is not necessary for the first crop of tobacco in these rotations.

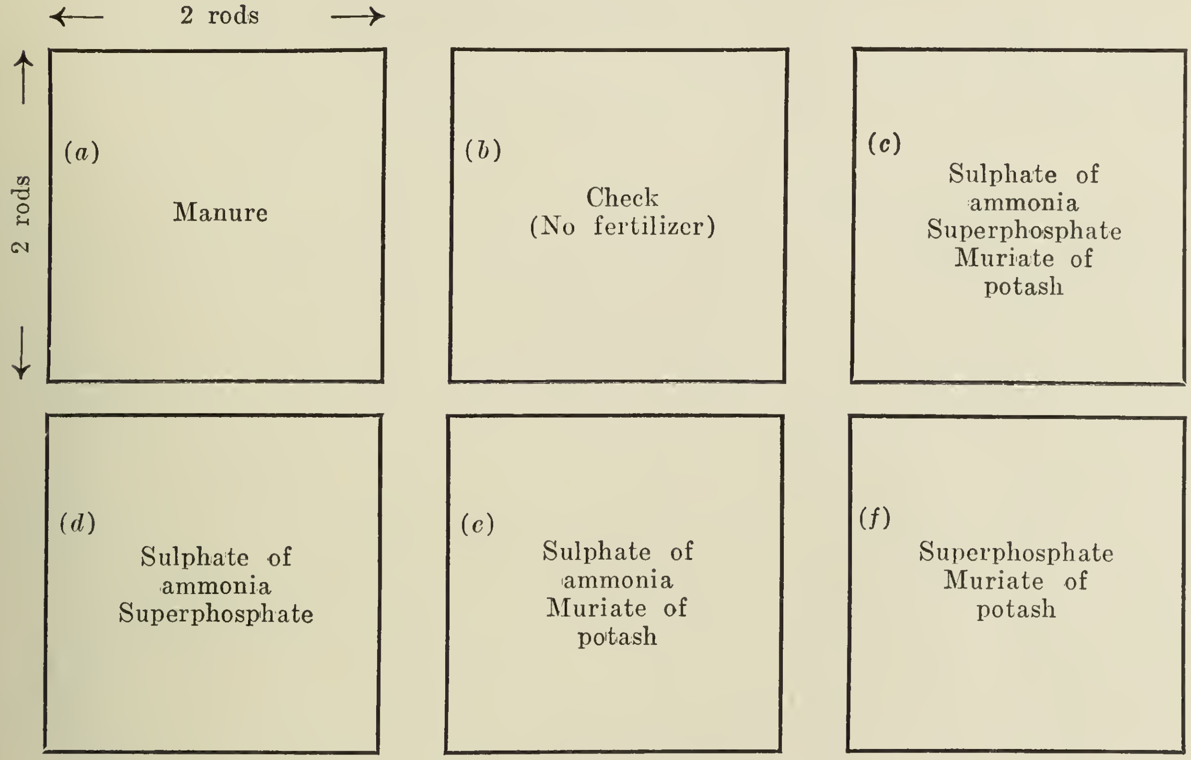
Suggestions for Private Tests of Fertilizers on the Farm

Before purchasing any fertilizing material on a large scale a farmer may wish to see for himself whether or not such a treatment will prove beneficial. This can most readily be done by applying the material in question to a small part of a field where no other treatment is used and comparing the yields on treated and untreated areas. The same thing can be done to determine the value of manure, limestone or other substances.

If more information is required, the following plan for a simple six-plot experiment is suggested:

CANADIAN AGRICULTURE LIBRARY
BIBLIOTHEQUE CANADIENNE DE L'AGRICULTURE
3 9073 00100202 3

PLAN FOR A SIMPLE SIX-PLOT EXPERIMENT—PLOTS 1/40 ACRE EACH (2 RODS SQUARE)



In this plan, the effect obtained from the application of manure or complete fertilizer may be noted by comparing the crop on (*a*) and (*c*) with that on (*b*). The influence of nitrogen, phosphoric acid and potash may be noted by comparing the crops on (*f*), (*e*) and (*d*) respectively, with that on (*c*). If the effect of ground limestone is wanted, a second set of plots similar to the above but with the limestone added to each plot, could be laid out.

The rates of application of the fertilizer materials for the crop under trial in the above plans may be those suggested previously for that crop. Since the size of the plots illustrated is 1/40 acre (2 rods square) the amount of fertilizer per plot will be 1/40 of the amount recommended per acre. However, the size and arrangement of the plots may be varied to suit local conditions. It is suggested that the size be such that the crop from each plot may be weighed or measured.

EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1956